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menting' leaves revealed the absence of extended bacterial colonies, the presence of which were naturally to be expected if *bacteria* were the cause of the phenomena in question. The true cause, I have recently established beyond a doubt, is the presence of two kinds of *oxidizing enzymes* in the tobacco leaves. As soon as the Bulletin describing these investigations is published a full review will be given in this JOURNAL.

OSCAR LOEW.

DIVISION OF VEGETABLE PHYSIOLOGY AND PATHOLOGY, U. S. DEPT. OF AGRICULTURE.

THE ANÆSTHETIC EFFECTS OF A SINUSOIDAL CURRENT OF HIGH FREQUENCY.

TO THE EDITOR OF SCIENCE: In your issue of June 3, 1898, I had the honor of communicating an observation on the anæsthetic effects of a sinusoidal current of high frequency. I take the liberty of sending you the following further observations.

a. The anæsthetic effect may be produced by sending the current longitudinally along the nerve. Thus, a current sent along one of the nerves of the arm can be used to produce anæsthesia in parts of the arm supplied by it. With a pleasant current of about 28,000 alternations per second passing between the elbow and the hand, a needle can be painlessly run into the forearm.

b. At the suggestion of Professor B. Moore, of the Yale Medical School, I applied the current to the tongue, with a view to testing the theory that the sensation of taste may be due to vibratory stimuli. If the theory were true the fluctuations in the sinusoidal current might be expected to produce sensations of taste of various kinds. The experiment showed that fluctuations up to about 29,000 complete periods per second produce no sensations of taste whatever; the only sensation is that of tickling and puckering.

c. It should perhaps have been stated in my original communication that the main purpose of the investigations with the sinusoidal current was to determine the various sensations at different frequencies. They have been determined for two subjects as follows: (1) Threshold of sensation of touch at a frequency of about

480 complete alternations' per second; (2) threshold of disagreeableness at about 840; (3) threshold of pain at about 960; (4) disappearance of pain at about 1,440, followed by a peculiar, agreeable sensation; (5) disappearance of agreeableness at a point not yet determined, followed by a faint sensation; (6) disappearance of sensation at a point not yet determined. For constant conditions these figures are quite constant, the probable error ranging from $\frac{1}{10}$ of 1 % to 4 %.

d. Applying the electrodes to the nerves of the arm in a way to move the muscles of the forearm and hand I find a similar neuromuscular effect. As the current rises in frequency from zero the muscles contract steadily up to a certain point, after which they gradually relax. The process is the same when we start with a high frequency and descend to zero. The phenomenon can hardly be due to a diminished intensity of the high-frequency current.

e. It may be added that the instrument used is a Kennelly alternator run at a very high speed. Similar high-frequency machines have been used by Nikola Tesla, who has not recorded any of the above phenomena; possibly his machines do not produce sinusoidal currents.

f. Using another machine which simply interrupted a galvanic current up to 100,000 times per second I find that above a certain point (not yet measured) the interruptions cease to have any effect other than merely reducing the strength of the current when it is sent through the tissues.

E. W. SCRIPTURE.

YALE UNIVERSITY, NEW HAVEN, CONN.,
February 28, 1899.

NOTES ON PHYSICS.

THE METRIC SYSTEM.

THE Hartford Steam Boiler, Inspection and Insurance Company of Hartford, Conn., has issued a very neat and convenient volume, of 'pocket size,' containing tables for the Conversion of English weights and measures into their metric equivalents, and *vice versa*. It opens with a very interesting discussion of the metric system, which lacks, however, any recognition of the International Bureau of Weights and

Measures and the great work it has accomplished during the past twenty-five years. Nothing is said about the International Prototype units of length and mass, which are the real standards of the world to-day, and it is implied that the meter and kilogramme are, except for practical purposes, what they were defined to be a hundred years ago. The ratios of the metric to our customary units used, in the book, are not those legally adopted by the U. S. Office of Weights and Measures, but the differences are so small that the conversion tables are not sensibly in error. There is a growing use of the metric system in this country, the result of an increasing trade with foreign countries, and this book will satisfy every demand of those who are called upon to convert from one system to the other. The tables are so numerous that it is difficult to imagine a call for anything which the book does not contain, and a convenient index renders them quickly available. Much time is saved by carrying the tables up to one-hundred multiples of each unit, but in a few instances space and labor have been wasted in doing this, because of the impossibility of such conditions ever being realized. For instance, in the table for converting 'grammes in a cubic centimeter to ounces in a cubic inch,' there does not appear to be any necessity for going beyond 23 or 24—as there is no known substance denser than this. Thus more than three-quarters of this table can be of no use, and this is true of several tables of a similar character. On the whole the work is exceedingly well done, and the book ought to be much sought after. T. C. M.

THE ELECTROLYTIC INTERRUPTER FOR THE INDUCTION COIL.

WHEN a high electro-motive force is connected to an electrolytic cell, one electrode of which is very small, the rush of current which takes place is quickly interrupted by the layer of gas which is generated at the small electrode. This layer of gas then collects as a bubble, the electrolyte again comes into contact with the electrode, a rush of current again takes place to be interrupted as before, and so on. These interruptions are very abrupt, and their frequency varies from two or three hundred to a thousand or more per second according to the size of the

small electrode and the inductance of the circuit. The small electrode should be the anode.

Dr. A. Wehnelt (*Electrical Engineer*, February 16, 1899) has applied this electrolytic interrupter to the induction coil. He uses dilute sulphuric acid, a sheet of lead as cathode, and the tip of a small platinum wire projecting from a glass tube as anode. The interrupter works with entire satisfaction with electro-motive forces as high as 110 volts; the condenser, needed with the ordinary interrupter, is useless; and the effectiveness, especially of small coils, is greatly increased both in length of spark and frequency.

Dr. Wehnelt's experiments have been repeated in the Physical Laboratory at Bethlehem Pa., his results have been confirmed, and it has been found that the primary of an induction coil should be wound with more turns of wire than usual to give the best results with this electrolytic interrupter. The interrupter gives good effects when used to supply intermittent current to the primary of a small transformer. Thus a small step-down transformer taking 375 watts from the mains gave out about 30 watts from its secondary.

When the electrolytic interrupter is used to supply intermittent current from a 110 volt source to the primary of a transformer, the e. m. f. which establishes the current after each break is, of course, 110 volts, while the e. m. f. which stops the current is the e. m. f. between the break points and may be very greatly in excess of 110 volts.

The effective primary e. m. f. is, therefore, on the whole, greatly in excess of 110 volts, so that a 1:1 transformer may give several hundreds of volts at its secondary terminals when supplied with intermittent current from a 110 volt source.

This is shown by the fact that a 220 volt lamp, for example, may be lighted from the secondary, and, of course, it may be lighted equally well or even better if connected across the primary terminals. W. S. F.

THE RESISTANCE OF CARBON AND COPPER BRUSHES.

PROFESSOR E. ARNOLD gives, in the *Electrical Zeitschrift* for January 5th, a study of the 'Con-

tact Resistance of Carbon and Copper Brushes and the Temperature Rise of the Commutator.' He finds that the contact resistance decreases with increase of current density, especially with higher velocities of commutator surface; thus, with a velocity of 368 meters (1205 ft.) per minute, the resistance per sq. cm. is for .7 amp. per sq. cm. .6 ohm., while for 10 amp. it becomes only .1 ohm., beyond which point it is nearly constant. He finds also that for a given current density the resistance increases with speed to a maximum, and then decreases for higher speeds; this he accounts for by supposing an unfavorable relation between the weight of the brush and the periodicity of the vibrations from passing over the segments; this theory is upheld by the fact that the same maximum appears at a lower speed for the heavier copper brush. A highly polished metal surface gives a higher resistance, which oiling increases still further. He mentions eddy currents as producing losses in the segments, and gives formulæ for the friction losses and the rise of the temperature.

F. C. C.

ENZYMES AS REMEDIES IN INFECTIOUS DISEASES.

DURING the past year Drs. R. Emmerich and Oscar Loew have been engaged upon an interesting problem in connection with enzymes as remedies in infectious diseases. The work was carried on in Munich, and as yet the results have not been published in full. We are indebted to Dr. Loew for the following facts in regard to the investigations: It has been surmised by Nencki and by Pfeiffer that the substances leading to recovery from infectious diseases, and producing immunity from them, belong to the enzymes. The latter author believed that these enzymes are prepared by the animal organs and not by bacteria themselves. Dr. de Schweinitz has observed an enzyme in cultures of the hog cholera germ which had a potent action in rendering guinea pigs insusceptible to this disease. However, this enzyme exhibited poisonous action in but little higher doses than necessary for immunizing.

Recently Emmerich and Loew have proved that certain kinds of bacteria, for example,

Bacillus pyocyaneus, produce enzymes which not only dissolve these bacilli themselves, but also other microbes, such as the germs of cholera, typhoid fever, anthrax, diphtheria, black plague, staphylococci and probably also gonococci. The germs of tuberculosis and many others are not affected by this enzyme within 24 hours. *Micrococcus prodigiosus* can also produce a bacteriolytic enzyme, which does not appear to act so favorably as that of the *Pyocyaneus*. The *Micrococcus erysipelatos* produces one, but this is associated, as in many other cases, with very poisonous qualities.* Emmerich and Loew have demonstrated that in a rabbit first infected with anthrax and then treated with subcutaneous injections of the concentrated enzyme of the *Bacillus pyocyaneus* the anthrax bacilli in the spleen are found completely broken up and partly dissolved, exactly as it can be observed *in vitro* when a dose of millions of anthrax and the other named bacilli are transferred into a few cubic centimeters of the concentrated and purified pyocyaneus enzyme. The latter enzyme can, by combination with an animal protein, be transformed into an immunizing substance. The authors have succeeded in obtaining both these agencies in a durable solid form. Thus the time seems near at hand when the treatment with serum will be replaced by a cheaper and simpler method, at least in certain cases.

B. T. GALLOWAY.

SCIENTIFIC NOTES AND NEWS.

THE refusal of Congress to establish a permanent census bureau for the proper conduct of the work has had its natural sequence in the appointment of a politician as Director of the Twelfth Census. The best that can be said of ex-Governor Merriam is that he had a creditable record as Governor of Minnesota. The New York *Evening Post* speaks of the appointment as follows: "Mr. Merriam is appointed Director of the Census simply because there was no other good office vacant at home or abroad. He has never had any experience as

*The bacillus of the black plague, that of tuberculosis, and other kinds, seem incapable of producing bacteriolytic enzymes, at least not to any noticeable degree, and the serum of black plague has, therefore, been applied without success in the cases at Vienna.